

XXV. *An Essay of Comparative Chætotaxy, or the arrangement of characteristic bristles of Diptera.* By C. R. OSTEN-SACKEN.*

[Read November 5th, 1884.]

I PROPOSE the term Chætotaxy for the arrangement of bristles on the different parts of the body of the Diptera, the composition of this term being analogous to phyllo-taxy, the order or arrangement of the leaves of plants. The characters derived from the number and position of bristles (macrochætæ) have been gradually gaining ground in dipterology, but it has not been attempted to introduce a uniform nomenclature for them. The study of the Diptera of South-Eastern Asia, on which I have been recently engaged, excited for the first time my more immediate interest in the bristle-bearing families of Diptera (Diptera chætophora) they may be called), whilst my attention had hitherto been confined to the *Tipulidæ*, *Tabanidæ*, *Syrphidæ*, &c., which are all bristleless (I propose to call them Diptera eremochæta). I soon perceived that I could not proceed much further with the study of the Diptera chætophora without an attempt at a comparative chætotaxy; and this gave occasion to the present essay.

In the choice of terms my principal aim was to prefer such that are more or less obvious, that is, to derive the names bestowed upon the macrochætæ from the places of their insertion. The bristles on the vertex, for instance, I call vertical bristles; those on the sides of the front, fronto-orbital, &c. Such terms offer the double

* The present paper appeared originally in the Mitth. d. Münchener Entom. Vereins, vol. v., pp. 121—138, 1881. In distributing my extra copies to correspondents I added a postscript, consisting of two pages printed on a separate sheet. (The contents of this postscript are reproduced in an article of mine in the Wien. Ent. Zeit., 1882, p. 91). In the present edition the substance of the postscript is incorporated in the body of the paper; a woodcut is added (borrowed from Prof. Mik's paper, 'Zu Osten-Sacken's Chætotaxie,' &c., in the Verh. z.-b. Ges. Wien, 1882); some useful remarks by Prof. Mik in the same paper are adverted to, and some additions are made on the last two pages. Otherwise the edition is unchanged, except a few emendations of little moment.—O. S.

advantage of being easily remembered, and not easily disputed; many of them have been anticipated by earlier writers. In following this plan, however, I met with a difficulty in the incomplete or uncertain terminology* of certain parts of the body of the Diptera, especially of the thorax, and this afforded me an opportunity for developing it. In doing this I purposely preferred a purely conventional to a homological or anatomical nomenclature. The latter is much easier to praise than to carry out, being often subject to uncertainty and dispute. Thus, what dipterologists hitherto called *metanotum* has been recently proved to belong to the mesothorax (see the paper of Mr. Hammond in the *Journal Linn. Soc.*, vol. xv.), and if the arrangement is sustained we shall have either to change the term for another or to continue to use it as a merely conventional term. The difficulties of descriptive Entomology are great enough without such uncertainty of terms, and it is evident that a conventional terminology offers more chances of fixity; it may very well exist alongside of a homological and anatomical terminology. It was principally the pleura which required some development of the nomenclature of its different regions, and of the sutures which divide them. The term pleura itself, being conventional, and not anatomical, I have formed the new names of the combinations of this word with other words indicative of the position of the parts which I intended to name (*mesopleura*, *metapleura*, &c.).

Bristles easily fall off, and the scars which they leave are not always recognisable; in such cases we may sometimes be in doubt whether we have a defective specimen or an individual aberration before us. Statements about chaetotaxy must therefore be made, as well as received, with some caution.

It is hardly necessary to add that in this, as in all my previous publications, I adopt Loew's terminology (explained in the *Monogr. N. Am. Dipt.*, vol. i.) as my rule and the basis to start from, only I prefer the Latin terms to their equivalents in English. Although somewhat incomplete and too hastily written, that chapter was composed by Loew at a late period of his career, and

* I deliberately prefer *terminology*, which is consecrated by usage and by the best writers, to *horismology*, which is not to be found in Webster's Dictionary, except in the incorrect form of *orismology*.

with the full benefit of a long experience. It was a deliberate attempt (as Loew says in the introduction to it) to act as an arbiter between the conflicting terminologies of previous writers, and for this reason it deserves the highest consideration. In the nomenclature of bristles I have taken into account the terms introduced by earlier writers, as far as consistency permitted it.

Sufficient attention has not yet been paid to the functions of the macrochætæ in Diptera, and to the remarkable circumstance that, while they occur with great regularity through a long series of families, they are wanting in others.

Among the *Orthorhapha* the Diptera eremochætæ (bristleless) form the rule, the chætophora the exception; but this exception comprises the large and important families of *Asilidæ* and *Dolichopodidæ*. (The bristles on the legs of the *Mycetophilidæ* and *Culicidæ* are not properly macrochætæ).

Among the *Cyclorhapha* the Diptera chætophora are the rule; the eremochætæ form the exception, but a very important one—the large family of *Syrphidæ*.

Macquart thought that the macrochætæ serve as a protection to the parts of the body upon which they are inserted; that they act as buffers in cases of sudden contact. In the Introduction to his 'Nouvelles Observations sur les Tachinaires' (Ann. Soc. Entom. Fr., 1845, pp. 239—240) he says:—"En examinant la situation et la direction de ces soies, qui sont d'ailleurs les mêmes dans la plupart des Muscides, il est impossible d'en méconnaître la destination. Elles protègent toutes les parties supérieures de la tête contre les chocs, et l'on ne peut guère douter que ces moyens de préservation n'aient été accordés à cette famille immense, à l'exclusion de la généralité des autres Diptères, pour compenser la faiblesse des tégumens. Les quatre soies occipitales, en se dirigeant en arrière, défendent le cou; les deux stemmatiques, tournées en avant, préviennent les dangers auxquelles les ocelles sont exposés, surtout pendant le vol; les latérales du rang intérieur, dirigées en dedans, forment une voûte pour abriter le crâne qui recouvre le cerveau; enfin, celles du rang inférieur dans les femelles, tournées en avant, défendent les côtés du front, élargis dans ce sexe." Macquart might have continued in the same strain about the bristles of the thorax; the supra-alar bristles protect the root of the wings from above; the

mesopleural perform the same office in front; the meta-pleural fan of bristles (in certain families) acts as a screen in front of the halteres, &c. Hence the persistency of the certain bristles in the same places, not only through the immense divisions of the *Calyptrata* and *Acalyptrata*, but even among more distant families, like *Asilidæ* and *Dolichopididæ*; hence also the possibility of a uniform terminology.

Still, this hypothesis of Macquart's does not explain how certain families can exist without any macrochætæ at all. The integuments of a *Tabanid* are apparently not harder than those of a *Tachina*, and yet they are unprotected by bristles. We may perhaps get over this difficulty by observing the different mode of locomotion of different groups of Diptera. There is a well-marked contrast in this respect between the aerial Diptera, which are most of the time on the wing and use their legs merely for alighting (*Tabanidæ*, *Bombylidæ*, *Syrphidæ*), and the pedestrian Diptera, which use their legs for running or seizing their prey, and fly only at intervals (most of the *Cyclorhapha*, except the *Syrphidæ*; among the *Orthorhapha*, the *Asilidæ* and *Dolichopodidæ*). The pedestrian Diptera are those principally provided with macrochætæ, probably because in their mode of life—running upon leaves, struggling with their prey, or ovipositing on caterpillars—they are more exposed to contacts and collisions than the aerial Diptera. The latter are not only in this respect less exposed, but most of them possess the power of regulating the momentum of their flight, which involves the faculty of poisoning themselves in the air. Observe the flight of a *Syrphus*, the cautious way in which he turns round a solid object and repeatedly touches it with the tip of his tarsi, without alighting, and compare it to the headlong flight of a *Calliphora*. The most bristly of all the Diptera and the least cautious in their flight are the *Calyptrata*, those very flies which C. C. Sprengel, in his 'Das entdeckte Geheimniss der Natur, 1793,' called the "stupid flies" (die dumme Fliegen), for their clumsiness, their inability to discover honey in flowers, and the ease with which they are deceived by odours and appearances. *Stratiomyidæ*, *Tabanidæ*, *Bombylidæ*, *Syrphidæ*, all have the power of poisoning, and all are absolutely or nearly eremochæta. *Therevidæ* and *Empidæ*, which also have that power, are provided with only very few macrochætæ. I assume,

therefore, that macrochætæ are organs of orientation, connected with the nervous system, being in their useful action not unlike the whiskers of a cat.

We may go further, and connect this generalisation with another one which I recommend to the attention of observers. That faculty of poisoning seems, for some as yet unknown reason, to be connected with contiguous eyes in the male sex. Most of the above-named families of Diptera eremochæta which possess that faculty (*Tabanidæ*, *Bombylidæ*, *Syrphidæ*, &c.) have holoptic males (as I will call them for brevity's sake). The Diptera chætophora hardly ever have holoptic males (even among the *Orthorhapha*, as the *Asilidæ* and *Dolichopodidæ*), the only exceptions, as far as I remember, occur among certain *Calyptrata* (for instance, *Hydrotæa*, *Ophyra*, *Homalomyia*), and it is very remarkable that just these possess, more than their relatives, the faculty of regulating their momentum. *Diaphorus* (*Dolichopodidæ*) is, by exception, also holoptic. Thus we have on one side an opposition between macrochætæ and eyes; on the other side a coincidence between macrochætæ and legs.

The Diptera eremochæta, as I have shown, are for the most part holoptic in the male sex; at the same time they are principally aërial insects; they use their wings for locomotion, their legs for alighting only (*Stratiomyidæ*, *Bombylidæ*, *Tabanidæ*, most *Syrphidæ*,* &c.).

On the contrary, the Diptera chætophora use their legs as much as, sometimes more than, their wings; they run, climb, snatch their prey, &c. (most of the *Muscidæ*, *Phoridæ*, *Dolichopodidæ*, *Asilidæ*); in consequence, their legs are much more developed and differentiated than the legs of the eremochæta, but the males are very seldom holoptic. What a contrast, for instance, between the soaring, bristleless, holoptic *Bombylius*, and the bristly, pedestrian *Phora*!

These two groups do not, however, embrace all the Diptera. The *Tipulidæ*, for instance, cannot be called

* Among the *Syrphidæ*, *Chilosia*, *Chrysochlamys*, *Vobucella*, *Rhingia*, and *Brachyopa* have some macrochætæ on the sides of the thorax and on the scutellum, but none on the head. Some *Syrphidæ*, like *Xylota*, are occasionally seen running upon leaves; Grischner (Wien. Ent. Zeit., 1884, p. 200) makes the same observation on *Calliprobola spcciosa*; but these are exceptions to the usual aërial habits of *Syrphidæ*. Certain *Bombylidæ*, like *Toxophora* and *Mulio*, have conspicuous macrochætæ, and the males are nevertheless holoptic.

either aërial or pedestrian; at the same time they are neither holoptic nor chætophorous.

"Insects organised for an exclusively aërial life," says Dr. A. Forel (*Libellula, Tabanus, Bombylius, &c.*), "depend on their eyes; they generally have very little developed antennæ, and are absolutely helpless in the dark; they hardly dare to walk. . . . In other insects (for instance, ants) the eyes play a subordinate part; these may be called antennal insects; they can work by night or underground, as well as by day" (A. Forel, *Beitrag z. Kenntniss der Sinnesempfindungen der Insecten; Mitth. d. Münchener Entom. Vereins, ii., 1878*). *Tipulidæ* and some of the *Nemocera* in general, *Chironomidæ, Mycetophilidæ,* and *Cecidomyidæ* may probably be ranked among the antennal insects. *Culex*, for instance, attacks us in the dark, following the scent by means of its antennæ. In the male *Culex*, according to the observations of A. M. Mayer, the antennæ are organs of hearing, and serve to discover at a distance the piping of the female (see *Amer. Journ. of Sci., vol. 108, pp. 89—103*). Thus the secondary sexual character of *Culex*, consisting in the different structure of the antennæ, would find its natural explanation in a functional difference.

It is by no means impossible that the macrochætæ are useful in more than one way; it will belong to the observer and the anatomist to determine whether, for instance, they may not serve for the transmission of sound (mere perception of the sound-waves of the air, and not specific hearing), like the long antennæ of certain Orthoptera or moths.

The further discussion of this subject would draw me beyond my present aim, which is a merely practical one, the settlement of the terminology of the macrochætæ, and, by that means, the utilisation of a set of characters which, it seems to me, have not yet been sufficiently appreciated in descriptive Entomology.

I.—TERMINOLOGY OF THE PARTS OF THE THORAX.

This terminology refers especially to the *Diptera Cyclorhapha*; but the same sutures and regions of the pleuræ can be recognised more or less distinctly in the *Orthorhapha*. Some of the sutures sometimes become less distinct or obsolete—for instance, in the *Tipulidæ*.

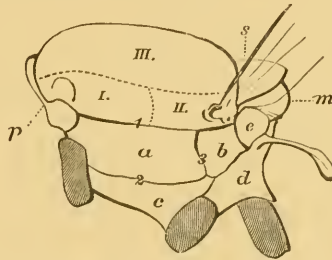
The appended figure is borrowed from Prof. Mik (*l. c.*); *p* is the prothorax, *s* the scutellum.

A. SUTURES.

Dorsopleural suture.—It runs from the humerus to the root of the wing, and separates the mesonotum (or tergum) from the pleura. (No. 1 in the figure).

Sternopleural suture.—Horizontal suture below the dorsopleural and parallel to it; it separates the mesopleura from the mesosternum. (No. 2 in the figure).

Mesopleural suture.—Runs from the root of the wing downwards, and separates the mesopleura from the pteropleura. (No. 3 in the figure).



B. PORTIONS OF THE PLEURA.

Mesopleura, square piece in front of the root of the wing, and between the dorsopleural and sternopleural sutures. It answers to the anterior lateral plate of the mesothorax of Lowne (*Anat. of the Blowfly*, Plate 5, f. 5), and to the parapteron of Hammond ('On the Thorax of the Blowfly,' *Journ. Linn. Soc.*, xv., pl. i.). (*a* of the figure).

Pteropleura, situated under the insertion of the wing, and behind the mesopleural suture. It is the posterior lateral plate of the mesothorax of Lowne, and the episternum of the mesothorax of Hammond (*l. c.*). (*b* of the figure).

Sternopleura; it is that portion of the mesosternum which, from its position, forms a part of the pleura (*c* of the figure). It is convenient to have a separate name for it, as very important bristles are inserted upon it, although it is not separated by any suture from the middle portion of the mesosternum.

Hypopleura, a distinct piece above the two last pairs of coxæ, and behind the sternopleura, from which it is

separated by a suture. It answers to the side of the metasternum of Lowne, and the epimeron of the mesothorax of Hammond. (*d* of the figure).

Metapleura, immediately above the hypopleura, and behind the pteropleura; a more or less convex, tubercular piece between the root of the wing and the haltere: in the *Asilidæ* it bears a characteristic fan-like row of bristles; between it and the metanotum the *callus metanoti lateralis* of Loew (Mon. N. A. Dipt., i., p. xiv.) is placed. (*e* of the figure).

C. OTHER TERMS FOR PARTS OF THE THORAX.

Scutellar bridges, the small ligaments which on each side of the scutellum connect it with the mesonotum, crossing the intervening suture. (Prof. Mik proposes to call them in Latin, *jugum scutellare*).

Præsutural depression; a triangular depression usually existing in the angle formed by the transverse mesothoracic suture and the dorso-pleural suture; a slight swelling at its bottom is the *præalar callus*.

Præalar and postalar callus; more or less distinct tubercles which often exist, the former in front of the wing, the latter between its root and the scutellum; they often bear characteristic bristles. (In my former writings I have occasionally used the term *præscutellar callus* for post-alar, but the latter is preferable). The word *callus*, here as elsewhere, is taken for the German *Schwiele*, in the sense of tubercle, swelling, and not merely of a hardness of the skin (which is the sense of *callus* in Webster's Dictionary). In this, as in other cases, I have preserved the terminology adopted by Loew in the Monogr. N. A. Dipt., vol. i. (1862).

Supra-alar cavity, an excavation of the mesothorax above the root of the wing, along the edge of which the supra-alar bristles are inserted. It is divided into an anterior and a posterior portion by a small ligament, which runs towards the root of the wing (*alar frenum*).

II.—THE TERMINOLOGY OF THE BRISTLES.

1.—In studying the chætotaxy of the Diptera it was natural for me to begin with those families in which the arrangement of the bristles is the most simple, that is, with the *Diptera Acalyptata*. After having adopted a terminology for these, the next step was to ascertain

how far it was applicable to the other great divisions of Diptera. I found that the homologies were so striking that there was no great difficulty in applying the same nomenclature of bristles to all the large divisions of the order. The terminology given below refers, therefore, first of all to the *Acalyprata* (especially the *Ortalidæ* and *Trypetidæ*); but at the end of this paper a brief sketch of its application to the principal other divisions is given. This sketch is necessarily approximative, and not exhaustive; many other characteristic hairs and bristles remain in each family to be observed, described, and perhaps named; this is left to the specialist; my aim was, by indicating the homologies, to insure the uniformity of the nomenclature.

2.—It must be borne in mind that, in enumerating the lateral bristles of the head or thorax, one side only is always considered. Thus, two fronto-orbital bristles means that there are two on each side of the head. On the contrary, the bristles on the central portions of the head or thorax are enumerated in pairs. Thus, vertical bristles, one inner and one outer pair, means that there are two vertical bristles on each side, one of which belongs to the inner, the other to the outer pair.

3.—The abdominal bristles do not require any special terminology; their position is easily defined by naming the abdominal segment on which they are inserted. Only the marginal bristles may be distinguished from the discal, as Rondani has done it (*Prodr.*, iii., p. 244). In describing the bristles on the legs, the rule enunciated by Prof. Mik (in his '*Dipterologische Untersuchungen*,' Vienna, 1878, p. 3, note) should be followed:—"On the legs I distinguish a front and hind side, and upper and under side. When a leg is stretched out horizontally, and perpendicularly to the longitudinal axis of the body, the front side is that which is turned towards the head; the hind side that which looks towards the anus; the meaning of upper and under side follows as a matter of course. I call præapical bristles those which occur principally on the front side of the hind femora of many *Dolichopodidæ*, single, elongated, erect bristles." The same term of præapical bristle was used by Dr. Schiner for a characteristic bristle at the end of the tibiæ in some *Acalyprata* (especially *Sciomyzidæ*). Thus the former would be the femoral, the latter the tibial præapical bristle.

A. CEPHALIC BRISTLES.*

Vertical bristles, so called from their position on the vertex; there are two pairs of them, the inner and the outer one; both are inserted more or less behind the upper and inner corner of the eye. They are either erect or the bristles of the inner pair are converging, those of the outer diverging. These two pairs of bristles are the most persistent of all, among the *Acalyprata*, although even they disappear in some genera. (For the identification of these bristles I recommend the head of *Tetanocera*).

Post-vertical pair of bristles, in the middle of the upper part of the occiput, behind an ideal straight line, connecting the vertical bristles of the inner pair. They are generally small or absent; large and conspicuous in *Tetanocera*.

Ocellar pair of bristles, on the ocellar triangle; they are always diverging and pointing forward; often wanting.

Fronto-orbital bristles, placed on each side of the front, near the orbit, immediately below the vertical bristles, on the little stripes which generally run down from the vertex on each side of the front of the *Ortalidæ*. There is only one pair of them (on each side), or two, one below the other; often none. In the *Ortalidæ* they are generally placed high on the front; in other families (*Tetanocera*, *Sapromyza*, &c.) they reach lower.

* The terminology of the parts of the head is confused and contradictory in different writers, and for this reason an explanation is necessary. Frontal orbit I call the whole interval between the frontal stripe and the eye. The term is not always appropriate, especially for the *Tachinidæ*, where that interval occupies the greater part of the front; but I prefer to retain it rather than to change the terminology adopted by Loew in the *Monogr. N. Am. Dipt.*, vol. i. These parts are the *Wangenscheitelplatten* of Prof. Brauer (*Die Zweiflügler des Kais. Mus. in Wien*), and the *optica frontis* of Rob. Desvoidy. When there is no distinct frontal stripe, as in some *Acalyprata* (for instance, the *Ephydridæ*), the dividing line of the orbits is merely an ideal one. There is no separate term in Loew for the portion of the face, very distinct in many *Cyclorhapha*, between the lower part of the frontal fissure and the antennal foveæ; a stripe which generally contains, in the *Calyptrata*, a vertical ridge bearing a row of bristles. We have no other choice but to use Robineau Desvoidy's term *facialium* (plural, *facialia*), also adopted by Walker. This piece is very distinct in the *Ephydridæ*, and, although level here, it is bounded by sutures and often bears a row of hairs. Stenhammar calls it *epistomatis partes laterales*, which is too cumbrous for use.

Lower fronto-orbital bristles occupy the lower part of the front, above the antenna, along the orbit. They are differentiated from the ordinary fronto-orbital bristles in not being quite in a line with them—that is, in being inserted either a little nearer to the orbit (*Trypetidæ*) or a little farther (*Scatophagidæ*); they also differ from the upper fronto-orbital bristles in being smaller or inserted closer together. They are not of frequent occurrence.

Vibrissa (Meigen, vol. i., xxix.), a stout bristle on the lower end of the facialia, immediately above the peristomium and below the antennal foveæ on each side, often accompanied by some smaller bristles. *Vibrissæ* are characteristic of some families; they are wanting in the *Trypetidæ* and *Ortalidæ*.

Facial bristles,* inserted in a series on each side of the middle portion of the face, above the vibrissæ, along the facialia; they are especially conspicuous in the *Tachinidæ*. They are rare among the *Acalyprata*; the *Ephydridæ*, for instance, have some weak ones on each side of the face.

In some genera other characteristic bristles occur, less persistent than those enumerated above, that is, appearing sometimes in one species and disappearing in another in the same genus. Such is an *occipito-orbital bristle* in some *Ortalidæ*, inserted on the posterior orbit of the eye; one or several *genal bristles* on the cheek, near the lower corner of the eye, &c. A row of bristles along the posterior orbit of the eye in the *Dolichopodidæ* have been aptly called by Loew *cilia of the posterior orbit*; similar bristles exist in the *Diptera Calyprata*, in the *Asilidæ*, &c. They are often plumose.

B. THORACIC DORSAL BRISTLES.

I divide the thoracic dorsum into regions, as they are indicated by the existing structural features: the dorsal stripes indicative of the position of the longitudinal thoracic muscles, and the thoracic transverse suture (or rather furrow) separating the anterior from the posterior bundles of the vertical muscles. Thus we obtain the

* Rondani (Prodr., iii., p. 244) calls the facial bristles *setæ orales*, a term which is misleading, because *oralis* means belonging to the mouth, as well as belonging to the face. (We have the oral organs and oral margin, both referring to the mouth). Rondani's other terms, *setæ verticales*, *ocellares*, and *frontales*, are the same as mine.

dorso-central region in the middle (III.), and the dorso-humeral (I.) and dorso-alar (II.) regions on each side. This division will be found very convenient for localising any bristle we may have to describe. These Roman numerals will be sometimes used by me to represent the corresponding regions. Thus *supra-alar* bristles (II.) will mean supra-alar bristles (dorso-alar region).

I. *Dorso-humeral region*.—It is bounded by the anterior end of the thorax and the thoracic transverse suture on two sides, and by the dorso-plural suture and dorso-central region on the two others (No. I. of the figure). I distinguish here:—

1. The *humeral bristle* (Loew, Europ. Helomyziden), inserted on the humeral callus; in the *Acalyptrata* either one or none at all; in the *Calyptrata* often several.

2. The *post-humeral bristles*, as far as I know, with rare exceptions, two inserted immediately above the dorso-pleural suture, between the humeral callus and the root of the wing; both are inserted at the bottom of the præsutural depression, a triangular depression which usually exists here in the *Cyclorhapha*.

3. A *præsutural bristle*, immediately in front of the thoracic suture, above the præsutural depression. It is not found in the *Ortalidæ*, but occurs in most *Trypetidæ*, *Sciomyzidæ*, and *Sapromyzidæ*. It may be homologous with a bristle in the same place in the *Diptera Calyptrata*, but which is less conspicuous among the other bristles which they have in the same region, and which I call *intra-humeral*. The *Asilidæ* possess very characteristic and persistent præsutural bristles (two or more).

The *Acalyptrata*, as far as I am aware, have no other bristles in the dorso-humeral region. The *Diptera Calyptrata* have several bristles besides, which may be called the *intra-humeral bristles*. There are often two, sometimes three or more of them, and they are inserted between the outer dorso-central row on one side, and the humeral callus and the præsutural depression on the other (compare below the notice on the *Diptera Calyptrata*).

II. *Dorso-alar region*.—Between the transverse suture and the scutellum on one side, and the root of the wings and the dorso-central region on the other (No. II. of the figure). In the *Acalyptrata* this region only contains the group of—

Supra-alar bristles, usually three; one is inserted on the post-alar callus (which is often indistinct in the *Ortalidæ*), very near the scutellar bridge and almost in a line with the præscutellar bristles; the second is in front of the first, just at the top of a small ridge or ligament (*alar frenum*), which descends to the root of the wing and crosses the supra-alar cavity; the third is in front of the second, on the edge of the anterior portion of that cavity. These bristles are not placed in a straight row; their bases form a triangle. A fourth supra-alar bristle sometimes exists in the *Ortalidæ*, behind the mesothoracic transverse suture and above the posterior post-humeral bristle. As far as I can ascertain, this last bristle is distinctive of the section *Ortalina*; I do not find it in the other sections of the *Ortalidæ*. The *Diptera Calyprata* often have a series of more than three supra-alar bristles along the edge of the anterior supra-alar cavity. Even among the *Asilidæ*, the supra-alar bristles form a distinct group.

The *Diptera Calyprata* show other bristles in the same region; they often form a longitudinal row of two or three, placed between the supra-alar group and the outer dorso-central row. They may be called *intra-alar bristles*.

III. *Dorso-central region*.—Bounded by two imaginary lines drawn from the scutellar bridges forward, and coinciding with a space free of bristles that exists on the outer side of the dorsal rows, and that is often occupied by a dorsal thoracic stripe (No. III. of the figure). This region contains the *dorso-central bristles*, arranged in two or four longitudinal rows. They are often wanting in the *Ortalidæ*. In the *Dolichopodidæ* the intermediate pair of rows is represented by two, sometimes only one (*Liancalus*) row of peculiar, minute bristles, which Prof. Mik (*Dipterol. Unters.*, Wien, 1878, and also *Verh. z.-b. Ges. Wien*, 1880, p. 600) calls the *acrostichal bristles*. In the absence of dorsal rows of bristles (for instance, in the *Ortalidæ*, *Tetanocera*, &c.) there is often a transverse row of four (or two) bristles in front of the scutellum; they represent the terminal bristles of the (here non-existing) dorsal rows. I call them *præscutellar bristles*. Sometimes (in *Trypeta*) there is only a single pair of præscutellar bristles, while a second pair, more in front and farther apart, represent the (absent) outer dorsal row. The præscutellar bristles are always inserted

between the scutellar bridges. A bristle usually existing immediately outside of the scutellar bridge, almost in a line with the præscutellar bristles, belongs to the dorso-alar region, and has been already mentioned above as the hindmost bristle of the supra-alar group. In the *Asilidæ* there are often two longitudinal short rows of small bristles in front of the scutellum; they may be called *præscutellar rows*.

C. THORACIC PLEURAL BRISTLES.

Prothoracic bristle (Loew, Monogr. N. Am. Dipt., iii., p. 33).—A strong bristle immediately above the front coxæ, which exists in Loew's division *Ortalina*. The bristle called *Borste über der Vorderhüfte* in Loew's paper on *Helomyzidæ*, p. 16, is homologous to this. It also exists in *Cordylura*, but not in *Scatophaga*; in the *Calyptrata* several bristles are generally found here.

Mesopleural bristles.—Inserted on the mesopleura, in the angle formed by the horizontal dorsopleural suture and the vertical mesopleural suture. There are often (for instance, in the section *Ortalina*) several bristles here, arranged in a row along the vertical mesopleural suture; there are two such bristles in *Scatophaga*, none in *Dryomyza* nor in *Helomyza*. In the *Diptera Calyptrata* these bristles form a conspicuous row.

Sternopleural bristles.—One or several on the sternopleura, below the longitudinal sternopleural suture. In Loew's divisions *Ortalina* and *Cephalina* there is one such bristle above the middle coxæ. Loew calls it the *mesothoracic bristle*, which name I cannot adopt, however, as it is too indefinite. There is one such bristle in *Scatophaga*, one or two in *Helomyza* and *Blepharoptera*, two in *Sapromyza*, and three in *Dryomyza*; none in Loew's *Platystomina*. In some *Anthomyia* I perceive three (one anterior, two posterior); in some *Dexia* and *Tachina* also three (two anterior, one posterior); in *Sarcophaga* three (one anterior, one posterior, and one between them).

Pteropleural bristles.—Inserted on the pteropleura; are of rare occurrence, and generally difficult to perceive; *Trypeta*, for instance, has a weak bristle inserted on the pteropleura, under the root of the wing.

Metapleural bristles.—On the metapleura; they are especially conspicuous in the *Asilidæ*, where they form a fan-like row.

Hypopleural bristles.—On the hypopleura; as far as I have observed, occur only in some of the *Diptera Calyptрата*, which have a row or a tuft of them.

III.—APPLICATION OF THE TERMINOLOGY OF THE BRISTLES TO THE PRINCIPAL LARGE DIVISIONS OF DIPTERA.*

Diptera Acalyptрата.—To illustrate the chætotaxy of this division I select the genus *Trypeta*, as being provided with the most complete set of bristles among the *Acalyptрата*. The chætotaxy of the Trypetid *Platyparea pœciloptera* may be expressed thus:—

Head: Vertical bristles, outer pair but little shorter than the inner; post-vertical pair small; ocellar pair of moderate size; fronto-orbital (2); lower fronto-orbital (3).

Thoracic dorsum: I. Humeral (1), post-humeral (2), præsutural (1). II. Supra-alar (3). III. A præscutellar pair; a second pair more in front, but farther apart.

Pleura: Mesopleural (2), sternopleural (1), pteropleural (1, very small).

Scutellum (4).

This is the usual type of chætotaxy in the genus *Trypeta* in the wider sense; in describing, therefore, that of any given species it will suffice to say *chætotaxy normal*, and to indicate the differences. Instead of two fronto-orbital bristles, there is sometimes only one; instead of three lower fronto-orbital bristles, there are often only two: in some cases there are three dorso-central pairs of bristles, the third being in front of the suture (Loew, *Die Europ. Bohrfliegen*, p. 5); the scutellum has sometimes only two bristles, sometimes as many as six.

If we compare the above formula with the chætotaxy of the Asiatic Trypetid *Ptilona*, v. d. W., we perceive at once important differences, which lead us to the conclusion that the genus, although a Trypetid, cannot be

* An Arabic numeral, placed in brackets after the name of a bristle or bristles, indicates the number of them; the Roman numerals, whether placed before or in brackets behind, indicate the region of the thoracic dorsum where the bristle is inserted:—I., Dorso-humeral region; II., dorso-alar; III., dorso-central. Thus, one intra-alar bristle (II.) means one intra-alar bristle (dorso-alar region). This addition may seem superfluous, because the term intra-alar bristle already implies that the bristle belongs to the dorso-alar region; still, I have occasionally used it because I thought that, owing to the novelty of the subject, it would be easier thus to recall the position of the different bristles.

referred to *Trypeta* in the wider sense of Meigen and Loew. *Ptilona* (at least a species from the Philippine Islands, which I have before me, and which seems closely allied to *P. brevicornis*, v. d. W.) has no ocellar bristles; only one fronto-orbital, inserted very low down, a little above a single fronto-orbital of the lower row. On the thorax: I., no præsutural; III., only one pair of præscutellar bristles. The rest is normal. I hold the absence of the præsutural bristle (I.) as the more important and decisive character.

Some African species of *Dacus*, according to Loew, have no dorso-central bristles at all. (the Asiatic *Dacus*, which I can compare, have one præscutellar pair).

Loew (*l. c.*) describes the lateral bristles of the thoracic dorsum as forming two rows on each side; I believe that we gain a much clearer view of them when we consider separately those of the dorso-humeral and of the dorso-alar region. As soon as I adopted this mode of grouping I became aware of the importance of the præsutural bristle (I.), as characteristic of a true *Trypeta*, and of a bristle behind the suture (II.), which occurs in the section *Ortalina*, but is wanting in the other sections of the *Ortalidæ*.

In contrast to the complete chætotaxy of *Trypeta*, I will give an instance of an incomplete one, in *Psila fimetaria*.

Head: Vertical bristles, two pairs of medium size; ocellar pair very small; no post-vertical; no fronto-orbital.

Thoracic dorsum: I. One præsutural. II. Only two supra-alar, the posterior one is wanting. III. A præscutellar pair. (All the other dorsal bristles are wanting).

Pleura: No bristles. Scutellum: Two.

Diptera Calyptrata. — *Cephalic bristles*. — The vertical (improperly called *soies occipitales* by Macquart, Ann. Soc. Ent. Fr., 1845, p. 239), post-vertical, and ocellar (*soies stemmatiques* of Macquart) are easy to distinguish among the other hairs and bristles; the fronto-orbital bristles (*soies laterales* of Macquart) afford important characters in this family, and are sometimes very numerous, forming one or several rows. Among the *Tachinidæ* they afford secondary sexual characters. The facial bristles are also of importance here.

Pleural bristles. — They are represented by one or several prothoracic bristles above the front coxæ; by a number of mesopleural, and two, three, or four sterno-

pleural, the position of which may afford valuable generic characters. Most of the *Calyptrata*, except the *Anthomyiæ*, have a tuft or row of bristles on the hypopleura, a region which is destitute of them in the other families of Diptera.

The dorso-central region contains the usual four rows of bristles, more or less complete*; the dorso-humeral region one or several bristles on the humeral callus, two posthumeral, on the præsutural triangular depression, and a few other bristles, inserted in the interval between the humeral callus, the præsutural depression, and the outer row of the dorso-central region; these bristles I have called the *intra-humeral bristles*. In the *Anthomyiina* there are usually only two such bristles; one of them seems to be the homologue of the præsutural bristle of the *Acalyptrata*, and is inserted immediately above the præsutural depression; the other is in front of the former, near the humeral callus. In *Calliphora erythrocephala*, *Lucilia Cæsar*, &c., I perceive four such bristles that are more conspicuous than the others; three along the præsutural depression, the fourth near the humeral callus.

The dorso-alar region contains (usually) two posterior supra-alar bristles, inserted on the post-alar callus; the second of them, as usual among the *Acalyptrata* also, is placed immediately above the *alar frenum*; and a row of anterior supra-alar bristles, three or more, along the edge of the anterior supra-alar cavity. The other bristles of this region may be called the *intra-alar bristles*, and form a longitudinal series of two or three, between the supra-alar bristles and the outer row of the

* The outer row is called by Kowarz, "die inneren Dorsalborsten" (Die Dipterengatt. *Lasiops*. in den Mitth. d. Münchener Vereins, 1880, p. 125, note), because he applies to the *Muscidæ* the terminology adopted by Mik for the *Dolichopodidæ*. But I believe that, in a terminology generally applicable, it will be found much more convenient, even unavoidable, to distinguish the inner and outer pairs of rows of dorso-central bristles. When the inner rows are very much differentiated, as is the case in the *Dolichopodidæ*, they may be called by the name proposed by Prof. Mik for them—acrostichal bristles. But it must be borne in mind that these bristles represent the inner rows of the dorso-central bristles in a great many Diptera; and that it is for this reason inconvenient to call "innere dorsal Borsten" that pair of rows which in reality is the outer. This is one of those cases where it seems to me a change in the nomenclature adopted by former authors becomes unavoidable.

dorso-central. They sometimes form a spurious, irregular row or series with the intra-humeral bristles of the dorso-humeral region.

The passage from hairs to bristles is so gradual among the *Calyptrata* that the number of bristles of a given kind is sometimes difficult to state, and sometimes variable in the same species, adventitious hairs assuming the proportion of bristles. The more hairy a species is, the more it seems liable to such variations.

In the *Æstridæ*, as an exception, the differentiation between the macrochætæ and ordinary hairs is feebly developed in some genera, and not at all in others.

Syrphidæ are aerial, and generally destitute of macrochætæ; the exceptions have been noticed on p. 501.

Myopidæ.—Macrochætæ almost undeveloped, hardly distinguishable from hairs or minor bristles; undistinguishable in *Conops*; in *Stylogaster* a pair of conspicuous vertical bristles, and distinct fronto-orbital ones.

Dolichopodidæ.—Only one (outer) pair of vertical bristles; a post-vertical is so placed that it may be interpreted as the inner vertical pair. Ocellar pair very high on the vertex, between the vertical bristles, and very conspicuous. Cilia of the posterior orbit (Loew); humeral (1), post-humeral (2), some intra-humeral (I.), distinct supra-alar and intra-alar bristles (II.). In the dorso-central region two dorso-central outer rows; two (sometimes only one—*Lianealus*) rows of small bristles representing the inner dorso-central rows, and which Prof. Mik has called the *acrostichal bristles* (Dipterol. Untersuch., Wien, 1878). On the pleura, in *Dolichopus*, a characteristic prothoracic bristle. (Prof. Mik observes “*Medeterus* has from two to six bristles here, one above the other”).

Asilidæ.—The cephalic bristles are indistinct among numerous hairs. A pair of ocellar bristles, and another pair (immediately behind) are sometimes discernible. A series of occipito-orbital (often plumose) bristles are homologous to the cilia of the posterior orbit (Loew) of the *Dolichopodidæ*. On the thorax, one (*Leptogaster*) or more præsutural bristles (I.) are characteristic; several supra-alar bristles on the post-alar callus (II.); and a number of intra-alar bristles (*Asilus*); in *Leptogaster*, a very characteristic single intra-alar bristle (II.). Often two longitudinal præscutellar rows of a few short bristles. On the pleuræ, sometimes a few mesopleural

bristles (*Laphria*), often hardly distinguishable from hairs, and a characteristic fan-like row of metapleural bristles. (Mik says that Loew called it *Haarschirm* in the *Empidæ*).

There is a mine of systematic characters yet to be explored in the study of the chætotaxy of the *Asilidæ*. As an instance I will cite *Dasygogon diadema* and *D. teutonius*, placed by Loew in the same ultimate subdivision of *Dasygogon* (*sensu stricto*). A glance at the chætotaxy of these species shows that *D. teutonius* has no bristles on the scutellum, while in *D. diadema* the scutellum is beset with 4—6 strong macrochætæ. A further examination reveals other abundant differences in the arrangement of the bristles on the thorax and the legs; it discloses at the same time other characters peculiar to each of the species,—in the shape of the abdomen, in the structure of the forceps of the male, &c.,—all of which tend to prove that these species belong to two very distinct genera. And yet when we read the descriptions (not excepting even those of Loew) we find almost nothing but colours mentioned. When Rondani (*Prodr.*, i., p. 157, and *Corrigenda*, iv., p. 7) introduced a new genus for *D. diadema* (*Cheilopogon*, afterwards called *Scilopogon*), he did so merely because this species has the 4th posterior cell closed; in consequence of which other writers have placed in that genus all the *Dasygogoninæ* with a hook on the anterior tibiæ, which have the 4th posterior cell closed, without any regard to other characters or to other genera which may have been previously established for such species.

Midaidæ.—They are entirely destitute of macrochætæ, and I have shown (*Berl. Ent. Z.*, 1883, p. 292) that, for this as well as for other reasons, the relationship between them and the *Asilidæ* is not as close as is generally supposed.

Empidæ.—The characteristic bristles are often, as in the *Asilidæ*, indistinct among other hairs; but whenever these are less dense, some of the bristles become easily recognizable; one larger humeral, and several smaller ones; post-humeral bristles; a fan-like metapleural row, similar to that of the *Asilidæ*, &c.

Bombylidæ.—It is only in a very few genera of this extensive family that the macrochætæ are differentiated in a more or less striking manner from ordinary hairs. Thus in *Toxophora* there is a number of conspicuous

macrochætæ on the thorax; but as their bases are hidden by other, shorter hairs, their homologies can only be guessed at; on the head there is an ocellar pair, but no other macrochætæ. In accordance with this, *Toxophora* is among the least aërial among *Bombylidæ*; it has short wings, and remains most of the time on flowers. *Mulio obscurus* has many macrochætæ about the thorax, the nomenclature of which is as uncertain as that of the macrochætæ of *Toxophora*; the abdomen of *Mulio* also shows conspicuous rows of large bristles. The North American *Systropus*, although so little hairy that the macrochætæ would be easily perceptible, has none whatever. The same may be said of *Phthiria*. In the genera of *Anthracina* and *Bombylina*, which form the bulk of the family, the dense hairiness or fur prevents us seeing any macrochætæ; still, traces of them may be occasionally seen; for instance, among the yellowish fur of some *Bombylii* a pair of black hairs are often visible above the root of the wing, which may represent supra-alar bristles; in *Anthrax javæ* and congeners a tuft of macrochætæ exists on the post-alar callus.

Therevidæ.—With the species of *Thereva*, which are covered with a dense fur, we experience the same difficulty as with the *Bombylidæ*; but that difficulty vanishes with the glabrous or subglabrous species, and here we at once observe much more marked homologies with the normal chætotaxy of the other families. There are none of the normal cephalic pairs of bristles; even the ocellar pair, elsewhere so persistent, is wanting. No humeral bristles; a row of three or four bristles, which must be considered as post-humeral, as they are inserted on the triangular præsutural depression (which is distinctly visible here, although it cannot exactly be called a depression). Two anterior supra-alar bristles (on the edge of the anterior supra-alar cavity), and one posterior (on the post-alar callus). Two pairs (sometimes only one) of præscutellar bristles, one exactly in front of the other. Four scutellar bristles.

Stratiomyidæ, *Tabanidæ*, *Leptidæ*, *Acanthomeridæ*, and *Xylophagidæ* (if such a family exists, of which I am by no means certain) are entirely destitute of macrochætæ, and form a natural group, the Diptera eremochæta *par excellence*. I have never met with a single instance of the presence of any macrochætæ in those families. This

character is important, and of easy application in some doubtful cases. Thus several forms described as *Xylophagi* may at once be recognised as not belonging there by the presence of macrochætæ (for instance, *X. brunneus*, Wied., which is a Therevid). On the contrary, *Lampromyia*, which has no macrochætæ whatever, is a Leptid, and not an Empid, as has been sometimes contended.

Nemocera. — All the families forming this artificial group are destitute of macrochætæ. The stouter hairs on the thorax and scutellum of *Culex*, and the bristles on the legs of the *Mycetophilidæ* can hardly be considered as such.

The *Culicidæ*, *Chironomidæ*, and *Tipulidæ* are distinguished by the development and the sexual differentiation of the antennæ, which are in this case very probably the principal organs of orientation (as I have shown above, on p. 500). The same conclusion may perhaps be arrived at with regard to the *Cecidomyidæ* and *Mycetophilidæ*.

It is worthy of notice that *Simulidæ* and *Bibionidæ*, remarkable for the great sexual differentiation in the structure of head and eyes (holoptic males; differentiation between upper and lower facets), execute aerial dances, implying a power of regulating their flight.

The *Blepharoceridæ* may be placed in the same group. I have observed *Rhyphus* (holoptic male) performing a similar dance, which consists in a slow flight up and down with outstretched legs. In all these cases we see a confirmation of the connection I have adverted to above between holoptic eyes, the power of regulating the flight, and aerial life and dances.